"Made available under NASA sponsorship
In the interest of early and wide dissemination of Earth Resources Survey
Program information and without liability
for any use made thereof."

E7.3 10733
CR-133077

(E73-10733) SNOW SURVEY AND VEGETATION GROWTH IN HIGH MOUNTAINS (SWISS ALPS) Progress Report (Zurich Univ.) 9 p HC $3.00 CSCL 08L

N73-26339

Unclas
G3/13 00733

E R T S - 1

T Y P E II P R O G R E S S R E P O R T

SNOW SURVEY AND VEGETATION GROWTH IN HIGH MOUNTAINS

(SWISS ALPS)

S R 3 2 3 / I D F - 4 0 5

Principal Investigator: Prof.Dr. Harold HAEFNER
Department of Geography
University of Zurich

Blüemlisalpstrasse 10
8006 Z u r i c h
Switzerland

1. INTRODUCTION

At the beginning of the second three-months period of interpretation, we received the first magnetic tapes. Since SCC-images were not available we decided to not proceed with the snow mapping method as developped during the first interpretation period but to switch to digital processing (2.1.2). The second period therefore is characterized by experiments in digital processing, which did not lead to significant results during this short period but resulted in a clear concept of the further activities.

2. ACCOMPLISHMENT AND PROBLEMS ENCOUNTERED

First results of our ERTS-investigations were presented at different meetings such as the COSPAR-meeting in Constance (3).

The following research activities were undertaken by the different investigator groups:

2.1 Department of Geography, University of Zurich/ Department of Photography, Swiss Federal Institute of Technology, Zurich

2.1.1 Determination of the position of snow line altitude

A special base map 1 : 500'000 was constructed to transfer the areal extent of the snow cover as established by the described electronical-photographical method (2.1.1) into a map of sufficient details, allowing an accurate estimation of the position of temporary snow lines in different climatic regions, exposures etc.

The official topo-map 1 : 500'000 has only contour intervals of 200 meters and doesn't show the relief and the hydrographic features in sufficient detail as needed for the quality of the ERTS-imagery. Therefore we used the official topo-map 1 : 100'000 of which a special extract, showing the contour lines with an interval of 50 meters and the hydrological network only was reproduced in a graytone and reduced to 1 : 500'000.

A complete set of all 26 1 : 100'000 map-sheets of Switzerland, reduced to 1 : 500'000 is available in form of negatives and positive transparencies.

Transferences of the snow cover extracted from ERTS-images onto lith-film were undertaken but with unsatisfactory results. SYC-imagery only provides a good accuracy when small sections not larger than 20 x 20 kilometers are transferred at the same time. Otherwise the distortions cannot be eliminated properly. Because this is a very unefficient and time-consuming procedure we

decided to not continue for the time being and to wait until the geometrically corrected SCC-imagery is available.

Papers describing the method and problems were presented at the COSPAR-meeting in Constance by HAEFNER/GFELLER/SEIDEL (3. Lit. 1).

2.1.2 Digital processing

Magnetic tapes were received from image E-1076-09442.
The following experiments were undertaken:
- data input into a CDC-computer
- decodifying of the marginal information
- frequency distribution of the graytones
- reorganization of the data
- data output in form of prints and on film (photoprinter)

The first objectives are to divide an image into a number of smaller images, which can be reproduced by a film-plotter.

Problems under investigation are:
Elimination of the geometric distortions caused by relief to calculate the accurate extent of the snow cover (from digital terrain model) and the radiometric distortions caused by the relief and the shadows, by considering the following parameters:
- digital terrain model
- calculation of sun-angle for different dates and daytimes
- calculation of the extent of the shadows for different dates
- digital enhancement of the shadow-areas and of areas in different exposures
- digital separation of the radiometric equalized snow-areas

2.2 Department of Geography, University of Berne

The problems of detailed snow mapping on a regional basis in the Western part of the Swiss Alps are continued comparing ERTS-imagery with weather-satellite pictures, aerial photography and ground truth. An article by B. MESSERLI et al. (3. Lit. 5) that discusses the first results has been completed and is in print.

In addition systematic experiments with color-composites are under progress to determine the best suited color combinations and color enhancements for an elimination of several dominant landscape features such as settlements, forests, agricultural land-use types during different seasons and phenological stages. Test sites in the Cantone of Berne are studied on different color transparencies produced by substractive color-mixing and by combining transparencies of diffe-

rent color-intensities. For most of the examined features the best results were obtained when using cyan as the color-component for settlements, broad-leaf- and needleaf-forests, harvested cornfields and potatoe-fields. On the other hand no significant results were obtained for the differentiation of other vegetation types, of geological formations by means of color combination.

The following image-series were used for this study:
E-1039-09381-4 to 7
E-1059-09500-4 to 7
E-1060-09552-4 to 7
E-1078-09553-4 to 7

2.3 Swiss Institute of Meteorology

The meteorological interpretations of ERTS-1 images combined with weather satellite data in the high mountains of the Alps were continued, especially regarding the following three subjects:

a. Convective cloud populations in mountainous regions

a.1 By strong winds (more than 8 knots in mountains, 5 over flat regions) cumulus clouds in mountain areas surprisingly are organized in parallel rows like over seas and plains if the slopes and summits remain under the clouds or penetrate well in the cloud layer.

a.2 By calms or gentle wind, cumuli develop over the ridges and summits and along illuminated slopes if the mountains are higher than the bottom of the clouds. Over the snow covered slopes the convection starts much later.

a.3 The tendency to coalesce is strongly marked. Small clusters are observed soon after the beginning of the convection.

The following pictures were used for these studies:
E-1022-09442-4 to 7
E-1022-09435-4 to 7
E-1038-09381-4 to 7
E-1057-09383-4 to 7
E-1059-09433-4 to 7
E-1059-09500-4 to 7
E-1078-09555-4 to 7
E-1078-09553-4 to 7

b. Fog and stratus layers

b.1 Mapping of fog with ERTS-1 imagery is relatively easy. The determination of the top is made by using topographical maps (of about the same scale)

with contour lines and the hydrographic network. The transparencies can be enlarged and projected directly into the map. In comparison with the meteorological satellite pictures, a method for fog mapping and daily surveying of fog is under progress.

The following pictures were used:

E-1059-09493-4 to 7

E-1059-09500-4 to 7

E-1060-09552-4 to 7

E-1060-09554-4 to 7

b.2 Studies of the momentary development of the stratus layers in or over mountains:

Large breaks occur first over the valley floors if the stratus lies inside the mountains. They occur only over the large valleys if the layers are above the mountain tops but lower than the cirrus level. No definite organization could be determined as yet.

The following pictures were used:

E-1057-09383-4 to 7

E-1075-09384-4 to 7

E-1093-09384-4 to 7

E-1093-09390-4 to 7

c. Precipitation pattern

A "black spot" appears in picture E-1039-09381-7, which is not visible on following picture-series. The area was completly free of clouds so that no shadow-effects were present. It is postulated that a stratus layer has just disappeared before the picture was taken. The surface under the supposed stratus layer remained wet to appear darker than its surroundings in the MSS-band 7. Under certain circumstances it is possible to determine precipitation pattern from ERTS pictures.

The following pictures were used:

E-1038-09381-4 to 7

E-1075-09381-4 to 7

First results of these studies were presented at the COSPAR-meeting in Constance and will be published in a comprehensive article by A. PIAGET (3.Lit. 6)

2.4 Department of Geophysics, University of Milano

The following optic-photographic image enhancement techniques were employed:

1) Color Composition

2) Density Slicing

The laboratory was fitted with a multispectral projector for a simultaneous projection of the b & w images on the same screen and the possibility to vary the type of filters and the intensity of the projection light source.

For every subject of investigation the best combination of filter and light intensity is selected. The employed filters are normally yellow, magenta and cyan.

Band 6 in general doesn't contain additional information in comparison to band 5 and 7, in fact band 6 lowers the chromatic contrast when composed with band 5 and 7.

A photo contour process was used to emphasize particular subjects such as internal waters, fresh or melting snow, glaciers etc. to discriminate the graytone levels as appearing on the reference wedge on each ERTS-image. With this procedure it is possible to reach information on the water of the North Italian and Swiss Lakes and on the different reflecting types of snow. The following pictures were used:
E-1039-09381-4 to 6
E-1076-09442-4 to 7
E-1075-09381-4 to 7

2.5 Cartographic Problems

2.5.1 Comparison with topographic maps

The Department of Cartography (Prof. E. SPIESS), Swiss Federal Institute of Technology, Zurich, has used the pictures E-1076-09440-4 to 7 for a first visual comparison between identified drainage and woodland features on ERTS-images and on the National Map 1 : 500'000 for a test site of about 17'000 km^2. Relative and absolute accuracy of clearly identifiable planimetric detail was found to be within 50 meters on the ground. This indicates that ERTS-images would be precise enough as compilation basis for maps smaller than 1 : 250'000.

A fair amount of rivers has been distinguished, perhaps 40 percent of those mapped at 1 : 500'000. 95 percent of all lakes, down to a minimal surface of 0,1 km^2 were registered.

In a second step the images of channel 5 and 7 were copied by a slicing and masking process for certain densities on lith-film. This procedure resulted in a distinct separation of the lakes, disturbed only by some remaining parts of mountain shadows. The photographic separation of woodlands was very success-

ful in flat and hilly parts, but rather occasional and discouraging in mountainous areas.

2.5.2 Plastic shading

Dr. Ch. HERRMANN, Department of Geography, University of Zurich, has used ERTS-images as a basis for plastic shading. Of a test area (Lake Walenstadt and vicinity) of 8 x 8 cm, a b and w negative copy 1 : 500'000 of an enlarged ERTS-1 color composite was used. With a relative minimum amount of time the oblique illuminated shading could be completed and printed on a traditional topographic map 1 : 500'000. With the use of ERTS-images, the shading technique for the graphical presentation of the relief in small scale mapping of mountain terrain could well be improved and rationalized. Results of the investigation were reported as part of a paper, presented at the "22. Deutscher Kartographentag München" (22nd German Cartographic Meeting in Munich, 1973) and will be published soon (3. Lit. 3).

3. PUBLICATIONS

The following publication with results from ERTS-1 investigation were published or are in print:

1) H. HAEFNER, R. GFELLER, K. SEIDEL:
Mapping of Snow Cover in the Swiss Alps from ERTS-1 Imagery; Preprint of Paper for COSPAR-Meeting in Constance 1973, to be published in COSPAR-Proceedings

2) H. HAEFNER, K. ITTEN:
National Report of Switzerland on Earth Resources Observation from Satellite Imagery; Preprint of Paper for COSPAR-Meeting in Constance 1973, to be published in COSPAR-Proceedings

3) C. HERRMANN: Entwicklungsmöglichkeiten topographischer Uebersichtskarten Massstab 1 : 500'000; Color-Plates to Paper for "22. Deutscher Kartographentag, Munich 1973", to be published in "Kartographische Nachrichten", 4/1973

Of these publications, copies have been forwarded to the ERTS-Program Manager and NASA Office of International Affairs.

4) R. GFELLER, K. SEIDEL:
Determination de la Couverture Neigeuse d'une Chaine de Montagnes à l'Aide des Images reçues de Satellites; to be published in "LES SATELLITES METEOROLOGIQUES", Colloque Internationale, Paris 21-24 May 1973.

5) B. MESSERLI et al: Beiträge zum Klima des Raumes Bern; Ausgewählte Probleme und vorläufige Ergebnisse; to be published in "Mitteilungen der Geographischen Gesellschaft Bern 1973".

6) A. PIAGET: Meteorological Interpretation of ERTS-1 pictures; to be published in "Veröffentlichungen der Meteorologischen Zentralanstalt Zürich, 1973".

4. ERTS-IMAGE DESCRIPTOR FORM

The third form for the time period of November 1972 to February 1973 will be forwarded at the same time of this report.

5. SUMMARY OF PROGRESS FOR THE SIX MONTHS PERIOD

Several groups of investigators from different research institutions are combining their efforts and rendering their facilities and equipment for an extensive and thourough interdisciplinary interpretation of the 25 different ERTS-1-image-series received between August 1972 and February 1973. The investigations are under progress in different regions and on different subjects. The most important ones are:

5.1 Snow survey

Two different approaches are undertaken to study the changes of the snow cover in the Swiss Alps. The first one by the Department of Geography, University of Berne, concentrates on the more regional and local aspects in the Western part of Switzerland to map the position of the temporary snow-lines in detail and to compare its variation in different small alpine valleys, in different exposures etc.

The second approach is a joint effort by the Department of Photography, Swiss Federal Institute of Technology and the Department of Geography, University of Zurich, to study the methodological aspects of the development of operational mapping systems from the images as well as from magnetic tape.

So far a method was developed which combines the possibilities of a Quantimet QTM 720 to discriminate the exact density level of the snow cover for each individual image by visual control with the higher resolution of photographic techniques. The determined density level is used as index for the exposure time of a high resolution lith-film. In addition a careful comparison of the different bands showed that the registered extent of an old snow cover in band 7 is smaller than in band 4. Photos immediately taken after a new snowfall

do not show this phenomenon. It has to be concluded that with a combination of the different bands possibilities for a separation of different snow-types exist.

5.2 Meteorology

A combination of meteorological satellite pictures (ESSA/NOAA), ERTS-images, weather maps and vertical temperature and humidity profiles allows a synoptic interpretation of the evolution of mesoscale, even microscale meteorological systems and their influence on different ecosystems.

As first results from the investigations by PIAGET occur a description of the organization of cumulus clouds over mountain terrain, generation and decay of cloud pattern, aspects of cloud layers just before discipation in or over mountain valleys, the development of fading of convections, night inversions, the determination of cumulus tops and partly its bottoms etc.

5.3 Cartographic aspects

ERTS-images are an excellent tool for cartography, especially for the presentation of the relief of mountain terrain. A careful visual comparison between drainage and woodland features on the photos and the National Map 1 : 500'000 were made of a test area of about 17'000 km^2. As a result it was found that ERTS-photos are precise enough as compilation basis for maps smaller than 1 : 250'000.

Of a test area (Lake Walenstadt and vicinity) a black and white negative copy 1 : 500'000 of an enlarged ERTS-1 color composite was used as model for plastic shading. With a relative minimum amount of time the oblique illuminated shading could be completed and printed on a traditional topographic map 1 : 500'000.

Prof.Dr. H. Haefner